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Anti-Friction Bearing Specifications
FOR THE TRACTORS OF AMERICA

Prepared for Your Guidance as to the Correct Location and Designation of all Anti-Friction Bearings

WHEEL DRIVEN TYPE TRACTORS

Manufacturers	Models	Number of Motors Used	Number of Other Anti-Friction Bearings	Front Wheels	Fan	Belt Pulley	Transmission	Differential	Ball Pinion	Drive Wheels or Rear Axle
Advance-Rumely Thresher Co.	12-20	8					HYATT		HYATT	HYATT
Advance-Rumely Thresher Co.	16-30	6					HYATT			HYATT
Advance-Rumely Thresher Co.	20-40	8			HYATT	BALL	BALL	BALL	HYATT	BALL
Allis-Chalmers Mfg. Co.	6-12	1	4		HYATT	HYATT	HYATT		HYATT	HYATT
Allis-Chalmers Mfg. Co.	18-30	6			HYATT		HYATT	HYATT	HYATT	HYATT
American Tractor Corp.		12			HYATT	HYATT	HYATT	HYATT	HYATT	
Appleton Mfg. Co.	12-20	13	1		BALL		HYATT	HYATT		
Appleton Mfg. Co.	15-30	7	2							
Aultman & Taylor Machinery Co.							HYATT & BALL	TAPERED ROLLER	BALL	TAPERED ROLLER
Aultman & Taylor Machinery Co.	22-45 and 30-60			TAPERED & BALL	BALL	BALL	HYATT		HYATT	HYATT
Automotive Corp.	B-3	3	21				HYATT			
Avery Company	C	13				HYATT			HYATT	
Avery Company	5-10	7								
Avery Company	14-28	2							BALL	HYATT
Avery Company	18-36,75-90,40-80						HYATT & BALL			TAPERED ROLLER
Avery Company	35	9	12	HYATT	BALL	BALL	TAPERED ROLLER	TAPERED ROLLER		HYATT
Boring Farm Impl. Corp.	Wallis	7	6	HYATT	HYATT	HYATT	HYATT		HYATT	HYATT
J. I. Case Plow Works	10-18	8	2		BALL		HYATT		HYATT	HYATT
J. I. Case Threshing Machine Co.	15-27	10	4		BALL	HYATT	HYATT	TAPERED ROLLER	HYATT	HYATT
J. I. Case Threshing Machine Co.	22-40	11	10	TAPERED ROLLER	BALL	HYATT	HYATT		HYATT	
J. I. Case Threshing Machine Co.	12-24	7	5		HYATT					PLAIN ROLLER
Chase Tractor Co.	16-30	3	8		BALL	BALL	HYATT & BALL	TAPERED ROLLER	BALL	TAPERED ROLLER
Coleman Tractor Corp.		1	13	TAPERED ROLLER	HYATT	BALL	BALL	BALL	HYATT	
Dart Truck & Tractor Corp.		1	11		HYATT	BALL	HYATT & BALL	BALL	HYATT	HYATT
Dasch Mfg. Co.	10-20	6			BALL	BALL	HYATT & BALL	HYATT	HYATT	HYATT
Dayton-Dowd Co.	16-32	10		HYATT	HYATT	HYATT	HYATT	HYATT	HYATT	
Dubuque Tractor & Truck Co.	10-32	12	1	HYATT	BALL		HYATT			
Eagle Mfg. Co.	12-22 and 16-30	6			HYATT	BALL	HYATT & BALL		BALL	HYATT
Electric Wheel Co.	14-26	5	6	TAPERED ROLLER	BALL	HYATT	HYATT & BALL	BALL	HYATT	
Electric Wheel Co.	12-25	5	18	TAPERED ROLLER	HYATT	HYATT	HYATT	HYATT		TAPERED ROLLER
Emerson-Brantingham Impl. Co.	12-20 AR	12				HYATT	HYATT	BALL	HYATT	TAPERED ROLLER
Fageol Motors Co.	5-12	3	10	TAPERED ROLLER	HYATT	TAPERED ROLLER	HYATT	HYATT		HYATT
A. R. Farquhar Co., Ltd.	15-25	8	12	TAPERED ROLLER	HYATT		BALL	BALL	HYATT	TAPERED ROLLER
Ford Motor Co.	Fordson	2	18	TAPERED ROLLER	BALL	BALL	TAPERED ROLLER	TAPERED ROLLER	TAPERED ROLLER	
The Four-Drive Tractor Co.					HYATT	TAPERED ROLLER	HYATT	HYATT	HYATT	
Frick Co.	12-24 and 15-28	9	3		BALL	BALL	BALL			
General Ordnance Co.	14-28				BALL	HYATT	HYATT & BALL		HYATT	HYATT
Gray Tractor Co.	A and B	9	8	TAPERED ROLLER	HYATT	HYATT	HYATT	HYATT	HYATT	HYATT
Great Western Tractor Co.	20-30	18		HYATT	BALL	BALL	HYATT & BALL		BALL	
Hart-Parr Co.	30	2	4				HYATT & BALL	BALL	BALL	
Holton Tractor Co.	10-16	2	15	TAPERED ROLLER			HYATT & BALL		HYATT	
Huber Mfg. Co.	12-25	4	1		HYATT	HYATT	HYATT	HYATT		HYATT
Illinois Tractor Co.	18-30	14	1	HYATT	BALL	HYATT	BALL	BALL		
Indiana Silo & Tractor Co.	6-12				BALL	BALL	PLAIN ROLLER	PLAIN ROLLER	PLAIN ROLLER	PLAIN ROLLER
International Harvester Co.	8-16, 10-20					PLAIN ROLLER	HYATT	HYATT	HYATT	
Kansas City Hay Press Co.	15-30	8	6	BALL	BALL	HYATT	HYATT & BALL	BALL	BALL	HYATT
Kell Tractor Co.	10-20	4	10	TAPERED ROLLER	HYATT		HYATT			
[illegible] & Sons Mfg. Co.	14-24	2						BALL	BALL	
[illegible]se Tractor Co.	7-12		5		HYATT	BALL	HYATT	HYATT	HYATT	HYATT
[illegible]se Tractor Co.	12-24	11	1	HYATT	HYATT	HYATT	HYATT	HYATT	HYATT	HYATT
[illegible]ho Lawson Mfg. Co.	15-30	12	5	TAPERED ROLLER	HYATT & BALL	HYATT	HYATT	HYATT	HYATT	OWN ROLLER
[illegible] Tractor Co.	10-32	8		HYATT	BALL	HYATT	BALL	BALL	HYATT	HYATT
[illegible] Giant Co.	16-32 & 36-35	17	10	HYATT	HYATT & BALL	HYATT	HYATT	HYATT		HYATT
[illegible]polis Steel & Mchy. Co.	12-20	10			HYATT	HYATT	HYATT	HYATT	HYATT	HYATT
[illegible]polis Steel & Mchy. Co.	16-30	16		HYATT						
[illegible]polis Thr. Machine Co.	12-25					BALL	HYATT		HYATT	HYATT
[illegible]polis Thr. Machine Co.	18-30	7	1			HYATT	HYATT & BALL	HYATT	HYATT	HYATT
[illegible]r Plow Co.	D	13	3					HYATT	HYATT	HYATT
[illegible] Tractor Co.	15-24	10		HYATT	BALL	HYATT	HYATT			
[illegible] Tractor Co.	K and G	10		HYATT	HYATT	BALL	HYATT & BALL		BALL	
[illegible]t Tractor Co.	15-30	1	5		BALL	HYATT	HYATT	HYATT		
[illegible] Tractor Co.	J	13	1						TAPERED ROLLER	TAPERED ROLLER
[illegible]er Tractor Mfg. Co.	18-36	1	14	TAPERED ROLLER	HYATT	TAPERED ROLLER	TAPERED ROLLER	HYATT	HYATT	HYATT
[illegible]man Tractor Co.	15-30	17	5	HYATT	HYATT	HYATT	HYATT			
[illegible]Huron Eng. & Thr. Co.	12-25	1			HYATT	BALL	HYATT	HYATT	HYATT	HYATT
[illegible] Foundry & Machine Co.	12-25	14			HYATT	HYATT				
[illegible]ric Tractor & Engine Co.	10-20				BALL		BALL	BALL		
[illegible] Island Plow Co.	9-16,13-26				BALL	BALL	TAPERED ROLLER	TAPERED ROLLER	TAPERED ROLLER	TAPERED ROLLER
[illegible]30 & Company	12-24,15-30,20-40									
[illegible]ld & Company	40-60					HYATT	HYATT & BALL	HYATT	HYATT	HYATT
[illegible]es Tractor Co.	M	8	2				HYATT & BALL			
[illegible]ton Tractor Co.	D	4	7			BALL	BALL			HYATT
[illegible] Enoche Tractor Co.	6-12 & 9-18	4	14		BALL	HYATT	HYATT	HYATT	HYATT	HYATT
[illegible]y Tractor & Truck Co.	15-30			TAPERED ROLLER	HYATT	BALL	HYATT		HYATT	HYATT
[illegible]te Turn Tractor Co.	18-35	16		HYATT	HYATT	HYATT & BALL	HYATT	HYATT	HYATT	OWN ROLLER
[illegible]on Tractor Co.	18-36	7		HYATT	BALL	HYATT & BALL	BALL	BALL	BALL	HYATT & BALL
[illegible]e Mfg. Co.	15-27	3	19	TAPERED ROLLER	BALL	HYATT	HYATT		BALL	TAPERED ROLLER
[illegible] Stewart Tractor Co.	30-45	9	25	TAPERED ROLLER	BALL			BALL	HYATT	
[illegible]mond Mfg. Co.	15-30				BALL	HYATT	BALL	HYATT	HYATT	
[illegible]lor Engineering & Mfg. Co.	6-12	3	3		HYATT	HYATT	HYATT	TAPERED ROLLER	TAPERED ROLLER	TAPERED ROLLER
[illegible]er Mfg. Co.	14-25	10		TAPERED ROLLER	HYATT	TAPERED ROLLER	TAPERED ROLLER	TAPERED ROLLER	HYATT	HYATT
[illegible] Tractor & Mach. Co.	20-30			TAPERED ROLLER	HYATT	HYATT & TAPERED	TAPERED ROLLER	HYATT & BALL	HYATT	HYATT
[illegible]t Motors Corp.	12-24	6		HYATT	HYATT	HYATT	BALL	HYATT & BALL		HYATT & BALL
[illegible]ery Tractor Co.	9-16	8	14		BALL	HYATT	HYATT & BALL	HYATT & BALL		
[illegible] Tractor Co.	10-20	18	6	BALL	BALL	HYATT	HYATT			
[illegible]Spah Tractor Co.	15-30			TAPERED ROLLER	TAPERED ROLLER	HYATT	HYATT	HYATT	HYATT	HYATT
[illegible]erlco Gas Engine Co.	12-25	12			HYATT	HYATT	TAPERED ROLLER			
[illegible]ney Tractor Co.	9-18	2	4		HYATT	HYATT	HYATT	HYATT	HYATT	
[illegible]consin Farm Tractor Co.	10-32	12	1							

TRACK DRIVEN TYPE TRACTORS

Manufacturers	Models	Number of Motors Used	Number of Other Anti-Friction Bearings	Front Wheels	Fan	Belt Pulley	Transmission	Ball Pinion	Track Rollers and Idlers	Track Drive Sprockets
Austin Machinery Corp.	15-30 and 20-40	28	1			HYATT	HYATT	HYATT		HYATT
Bates Mach. & Tractor Co.	15-22	10	17	TAPERED ROLLER	BALL	HYATT	TAPERED ROLLER	HYATT	HYATT	TAPERED ROLLER
Bean Spray Pump Co.	8-16	4				BALL	BALL	HYATT & BALL	HYATT	HYATT
C. L. Best Gas Traction Co.	25	37	4		BALL	HYATT	HYATT	HYATT	HYATT	HYATT
C. L. Best Gas Traction Co.	60	27	14			HYATT & BALL	HYATT & BALL	HYATT		TAPERED ROLLER
Buckeye Mfg. Co.	25-40	4	14		HYATT	TAPERED ROLLER	HYATT	TAPERED ROLLER	TAPERED ROLLER	TAPERED ROLLER
Cleveland Tractor Co.	12-20	2	12		BALL	HYATT	BALL	BALL	HYATT	HYATT
Dayton-Dowd Co.	18-36	18			BALL	BALL	BALL	BALL	BALL	BALL
Franklin Tractor Co.									HYATT	HYATT
Franklin Tractor Co. (Bullock)		11	2		HYATT	HYATT	HYATT & BALL	HYATT	HYATT	BALL
General Tractors, Inc	36-18	25		HYATT	BALL	BALL	BALL	BALL	HYATT	HYATT
Hicks Tractor Co.	12-25	60	6		BALL	HYATT & BALL	HYATT	HYATT	HYATT	HYATT
[illegible]ch Mfg. Co.	[illegible]	[illegible]	4		[illegible]	HYATT & BALL	HYATT	HYATT	H	
[illegible]n Mfg. Co.	[illegible]	[illegible]	16		[illegible]T	TAPERED ROLLER	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]T	HYA	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	HYA	[illegible]	[illegible]	[illegible]	
Yuba Mfg. Co.	[illegible]	[illegible]	[illegible]		[illegible]	HYA	[illegible]	[illegible]	[illegible]	
Yuba Mfg. Co.	[illegible]	25	1		[illegible]	HYA	[illegible]	[illegible]	[illegible]	

HYATT Bearings predominate in the tractors of America. After years of experience, builders and users of Power Farming machinery have found Hyatt Bearings to be the most satisfactory.

No greater proof of this could be had than is found in this chart showing tractor anti-friction bearing specifications.

We will be glad to send you copy of the folder containing this chart.

HYATT ROLLER BEARING CO

Tractor Bearings Div.
Chicago

HYATT

ROLLER BEARINGS

Drainage

By James A. Reeves[1]

THE demand for increased food production and the high prices obtained for agricultural products have greatly enhanced farm land values and have stimulated both drainage improvements and drainage reclamation projects. Never have there been so many new drainage districts organized as during the past year.

In the case of tile drainage the demand may appear magnified on account of the curtailed production during the past several years; even though statistics show an increase in the value of drain tile manufactured. Considering that the cost of fuel, labor and materials has doubled during the last three years, the demand proves that the benefits far exceed the cost, and it leaves no doubt as to the merit of drainage investments.

Drainage costs are not recurring like the application of fertilizer and should be promptly added to the cost of each acre affected and will be immediately reflected in the value per acre; for, once installed, the earnings on this improvement are as continuous as the acre itself.

While the primary cause of the stimulation is happily removed, the lessons learned and the experience gained justify the carrying on of these worthy undertakings. There will be some fluctuations in food prices and in land values, but the benefits obtained through drainage are understood better than heretofore and no shrinkage in values which the most pessimistic person might predict would warrant the postponement of either private drainage improvements or of feasable systems of combined drainage or meritorious reclamation projects.

In order, however, that drainage improvements may be encouraged it is imperative that thought be given to the following important items:

Financing the cost of the improvement.

Elimination of unnecessary delays in organization.

Adequate distribution of agricultural products.

Considering the first it would seem that the certainty of suitable reward should be better advertised to the end that funds could be more readily obtainable. The question of State or Government aid should be carefully studied and a definite policy decided upon.

In considering the matter of delays in developing a drainage district to the point where a contract can be let it is only necessary to review the history of nearly every undertaking of this character to reach the conclusion that a great deal of time is wasted, resulting in needless losses in the failure to complete the work quickly and promptly put the land in cultivation. The suggestion is offered that if engineers were more accurate in their estimation of "benefits," instead of deeming it essential to have their figures unnecessarily low, that there would be greater incentive to expedite the proceedings. In many instances it would permit of contracts being made with the approval of the commissioners which would otherwise not be legal owing to the engineer's original estimate of "benefits" indicating that the work would be unprofitable, whereas, the facts show that at current construction costs, even greater profits would result to the owners than had ever been indicated or contemplated.

There is, however, a bigger problem to be solved by those contemplating investment in drainage and those interested in engineering and construction of drainage systems, namely, *Transportation*.

The failure of the railroads to function properly during the past several years has made this an important item, for a proper distribution of agricultural products is as necessary as is adequate production; and it concerns every family. Only recently a bountiful fruit crop went to waste on account of lack of transportation and not only have the people failed to obtain the fruit grown at reasonable cost, but the growers have failed to reap the benefits of their labors. Grain movement has been a serious problem for several years and is still a matter of grave concern.

It is curious how the average person views a car shortage or a freight rate increase and little does he realize how much it affects him and his living costs.

What would it profit one to reclaim or improve a lot of land at considerable expense and care, if after producing a bountiful crop, it became impossible to market it on account of inadequate transportation? Furthermore, failure to take advantage of market prices on account of inability to get the crop to market has caused enormous losses to the farmer, curtailed his purchasing power, made money scarce, and in many instances forced him to borrow money or to renew loans which otherwise would have been promptly paid.

At present empty cars are sent thousands of miles to serve certain communities. These cars are denied to other shippers much nearer at hand who suffer losses by reason of not having the service of cars passing his door, thus adding to his burden and to the cost of the merchandise. Frequently he is manufacturing or dealing in the very materials and supplies which the favored shipper is badly needing.

It seems unreasonable that this condition should exist when there lies almost immediately available a great nat-

[1] Sales Manager, Streator Drain Tile Co., Streator, Ill. Assoc. Amer. Soc. A. E.

ural waterway, situated at the very feet of the farmers whose needs for transportation are the greatest, and the distribution of whose produce means much to everybody, whether in the great Mississippi River Valley or remotely distant from its bountiful fields.

There was a time when it appeared advantageous to railroad interests to discourage any efforts to utilize this system of waterways but there should be no good reason at this time to continue such efforts. On the other hand, their interest would lie in encouraging such development for it would increase instead of reduce their earnings. A broad view would suggest looking far enough into the future to picture this nation after the reclamation of thirty million acres of land in the great Mississippi Valley. The tremendous crops to be moved require the construction of thousands of miles of new feeder railroads to take the grain and produce to the water.

To get a meager conception of the increased demands on transportation consider the effect of reclaiming through drainage a tract of ten thousand acres. To properly tile the land 1600 carloads of tile would be needed. Sixty-five new 160-acre farms are created and must be fully supplied with buildings, machinery, horses and cattle, all making heavy demands on manufacturers and carriers.

Many miles of new roads must be built and the adjacent settlements or hamlets bloom into villages and towns, bringing prosperity to the community. Streets are improved, sewers and water systems installed, calling for engineering talent; and, lest it be overlooked later, let us here mention that the taxable property is increased by three million dollars, adding to the wealth of the state and nation.

Consider now the transportation needs of these farms. At an average yield of thirty bushels per acre, 600 cars would be needed each year.

When we appreciate the effect of bringing into cultivation a mere unit of ten thousand acres of this wonderfully fertile land and the increased demand on transportation, how important this problem looms before us and how necessary it is that this society whose talent and influence are most needed in this programme should give serious thought and take suitable action concerning the matter.

When this great work is accomplished, as it surely will be, the river system and the railroads will have the appearance of an up-to-date drainage map, the rivers representing the mains and the railroads the tile laterals flowing to the mains, but instead of merely taking the surplus water to the sea they will carry the wealth produced from the richest agricultural land in the world.

Surface Inlets and Surface Outlets Figure in Selection of Run-Off Factor

By David Weeks[1]

AUTHORITIES differ regarding the use of surface inlets. Some hold that surface inlets should not be used at all, others say that surface inlets should be used in every depression, while others use inlets sparingly, and where inlets are used a corresponding increase in drainage coefficient is adopted. Every locality has its special drainage problems. It is interesting to hear a group of drainage engineers from different localities explain their problems and their methods. There are usually as many different opinions about a certain problem as there are engineers in the group. Upon investigation it is usually found that the method expressed fits some local condition. It is a local condition which forms the basis of this article, but one of common occurrence in the glacial regions.

There are many different types of glacial topography. Eastern South Dakota offers a variety of surface conditions, each presenting characteristic drainage problems. On the broad, flat ground moraine in the drainage area of the James River Valley the swamp areas are large, slopes are very flat and ridges between swamps are less pronounced than the more rugged topography in the region of Lake Traverse in the northeastern part of the same state. The writer is engaged in the design of extensive drainage systems in each of these areas. The need for an entirely different design for each is evident.

High costs of drain tile make it necessary to pay a great deal of attention to economic design. High factors of safety lead to lavish expenditures — the use of the flat rate of runoff must be discarded, and careful analysis made to determine the proper rate of runoff, not merely for the district as a whole, but for each portion of the system.

In the design of outlet systems for an area of about

[1] Drainage Engineer, Dakota Engineering Co., Mitchell, S. D. Mem. Amer. Soc. A. E.

30,000 acres in Roberts county, South Dakota, we are using a combination of surface outlets and surface inlets with a careful selection of drainage coefficient, to fit different portions of each system according to its characteristics. The general slope of the area is considerable. The surface is rugged, and but for the many obstructions left by the melting glaciers, the area would be naturally well drained. The sloughs of the area are comparatively small but very numerous with high barriers in some cases keeping the greatest floods from continuing in their course toward Cottonwood Slough, and thence into Lake

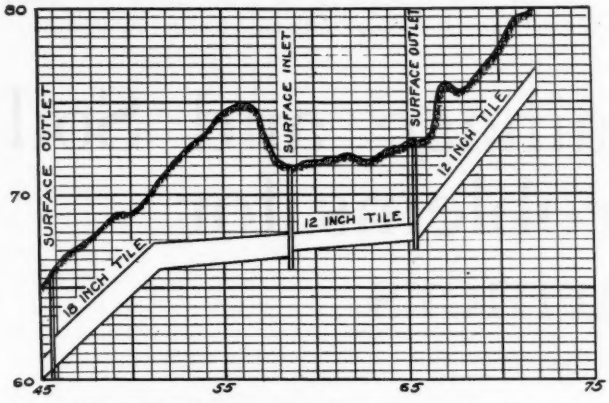

Fig. 1. A large runoff factor is necessary through a ridge while the coefficient may be reduced where part of the flow can be carried over the surface

Traverse, which forms the boundary between South Dakota and Minnesota.

Over the entire area there is not a quarter section of land that does not have numerous pot holes. It is planned to give each land owner an outlet for the drainage from his land. The available slope is great, thus reducing necessary tile sizes, but there are a number of deep cuts which will run the labor cost comparatively high. It is expected the net result will be an average cost per acre. The steeper slopes will make it possible to drain a larger area with a maximum economic tile size.

It is expected a more thorough drainage can be obtained by the use of surface inlets but with the steep gradient available some protection or relief must be provided for the prevention of "blowouts" below. At the same time an increase in drainage coefficient must be made below the inlet. If no surface relief or surface outlet were provided, this increased drainage coefficient must be continued to the outlet of the tile or to its junction with other portions of the system which will again make necessary a reconsideration of the coefficient according to the arrangement of tributary branches and their respective coefficients of drainage. It seems, however, that this would result in an unnecessary expenditure for additional tile size, and it is proposed to reduce the size of tile as soon as the ridge has been passed, using a surface outlet at the point of such reduction in size. The system will virtually serve two purposes: First, the surface water will be taken off as soon as possible, using the surface of the ground wherever the slope is sufficient instead of trying to carry it all in the tile. As soon as the surface flow has ceased, the tile will be at work lowering the water table in the soil and furnishing outlets to farm systems. Such a design will mean a coefficient larger than is usually applied through the ridges, and a coefficient smaller than is usually recommended for portions of the system where there is no obstruction to natural runoff.

The accompanying illustration (Fig. 1) shows the profile of one of the lines which has been staked out, and the location of the inlet and outlet. Below the surface outlet on this particular system there arises a situation which is common to a great many of our problems in South Dakota. In other states since the beginning of drainage the same situation has caused a great deal of litigation; that is, the matter of damages to lower lying lands. In this instance the outlet to the drainage could easily have been obtained at the point where the surface outlet is placed, but it was decided that a small tile should be carried on, to carry the dry weather flow, while the water table is being lowered in the swamps above. A surface outlet was therefore placed where shown to give outlet to the system while working full capacity. Under the laws of South Dakota as in many of the other central states, owners may drain their lands in the general course of natural drainage, throwing the water upon lower lying lands, but usually where damage can be actually shown such damage can be recovered. It was with a view of preventing such trouble that the smaller tile was carried

The only outlet for this swamp land in the immediate foreground is through the grain field shown on the sky line

on down the slope. Had surface conditions warranted, a regular outlet would have been designed with a surface inlet below, into the small tile. It will be noticed that the hydraulic gradient is carried to the surface of the ground at the outlet which is low enough not only to take the

surface water from the slough, but also much of the gravitational water in the soil.

The same reasoning in selection of drainage coefficient can be applied to open ditches but with an additional purpose. The bottom width of open ditches should be wider through the ridges in this kind of topography than through the sloughs or ground with a slope favorable to natural drainage. In most economical designs it is expected that during exceptional periods the land will be flooded as it would not pay to construct systems to properly care for conditions occurring only at rare intervals of time. Now consider one of these occasions when everything is flooded. There is a certain flow down the valley which together with the flow in the ditch must all be carried through the ridge. If the ditch through the ridge has sufficient capacity, the duration of flood will be shortened, and the resulting damage less. Deep cuts are harder to maintain than shallow cuts. It is harder to get machinery in for cleaning out, or reconstruction, so the importance of larger capacity through the deep cut is evident.

Topography is a very important factor to be considered in the selection of a runoff factor, and where the system is a tile system, the use of surface inlets, surface outlets, and a careful selection of the runoff factor may mean more thorough drainage with an actual saving in cost.

Solving the Drainage and Soil Washing Problems for the Farmers

By W. A. Steele[1]

I WILL not attempt to discuss the big subject of drainage in a scientific manner but in a simple, practical way will endeavor to show you how the drainage and soil washing problems for thousands of farmers both in this country and abroad are being solved.

When this country was yet in its embryo state and before man in his mad search for gold, and the onward rush of civilization, saw fit to destroy the virgin timber lands, there was little or no occasion to give the problem of water control any serious consideration.

The roots of the trees together with the yearly covering of leaves from the forests held back the water as it fell on the hillsides and slopes, thereby causing it to seep into the ground and conserve the moisture for growing vegetation, instead of rushing down the slopes, seeking a level and flooding low lands as it does today.

We all know that plants take their food in liquid form. If they get too much water they are drowned out, if too little they die for lack of nutriment. Thus the whole problem of drainage resolves itself into a problem of regulating the water.

We are fast learning the value of good drained land. All land to be at its best must contain a certain per cent of moisture. The trouble with undrained land is that it is either too wet or too dry. By dry soil I do not mean without water, but because of lack of drainage the water is not in the right place.

This same argument applies to land that is too wet. On account of improper drainage the water cannot get to the right spot.

Two Kinds of Drainage—Open and Under

No one questions that wherever practical, under or tile drainage is the best and most effective. It eliminates the open ditch, which to some farmers is objectionable, because they look upon it as a waste of just that much valuable land.

But there are instances where tile drainage is not feasible. To illustrate; on low level flat land where there is practically no fall, if any. In such cases the open ditch or surface drain is the only solution, and gives quick relief by removing directly the flood or surface water that often does so much harm. Such a ditch acts as a receiving drain for all water on land contingent to the ditch, and as the water seeps through the porous substratum it aids underdrainage as well.

Another thing to be considered is that the present scarcity and high price of tiling makes underdrainage prohibitive to the average farmer. So here again it is necessary that he use the only available means at hand to get rid of the excess water, namely, the open ditch.

Effects of Drainage

Drainage increases the temperature of the soil to a remarkable degree, making it warmer, dryer, more porous, and open. Plant roots can penetrate deeper, permitting the light and air to get to them which is not possible in a tightly packed water soaked soil.

Seed will germinate quicker, growth is more rapid,

[1] President Owensboro Ditcher and Grader Company. Revised paper read at Southern Section meeting of A. S. A. E.

crops mature earlier and the yield is much heavier. Actual observations in some sections of the country have proven that crops mature from two to three weeks earlier on drained land which often spells the difference between crop success and crop failure.

We all know that land that is properly drained can be cultivated much earlier in the spring than land on which water is allowed to remain standing all winter.

Drain the New Way

. The old laborious pick and shovel scraper and plow method of ditching has never been popular on account of the hard labor and drudgery involved. The large power driven tile ditching machines are too expensive to permit the average farmer to avail himself of their use.

To breach the gulf existing between these two extreme methods of ditching, was the purpose of designing the V-shaped ditched. That this machine is today solving the ditching and soil washing problems of thousands of farmers is best evidenced by its popularity among the farmers and numerous testimonials that are constantly being received from pleased users.

This machine hooked up with either two teams or with any type of farm tractor and two men can cut a mile of 3-ft. V-shaped ditch in a day. The V-shaped ditch can be used either for tile or open surface drainage or for irrigation laterals.

In case of tile drainage, with one of the larger models, ditches as deep as 4 ft. can be cut. All the hand work necessary is a little spading out of the bottom to make the correct grade.

We know of some cases where the cost of tiling has been reduced nearly 500% by the use of this V-shaped ditcher. One user wrote in saying that it saved him more than $2,000.00 on one job of laying 100,000 feet of tile.

To illustrate how the open surface drain, in cases where, on account of local conditions, tile drainage cannot be resorted to, will get the excess water off the land, I can do no better than give you the actual experience of two farmers, namely, Mr. J. W. Smyser of Sterling, Kansas, and Mr. M. Bodenheimer of Green Bay, Wisconsin.

"Two years ago I bought one of your ditcher and graders and used it on 580 acres of very wet land, so wet that nothing could be raised on it but bull-frogs. Before ditching we were unable to harvest a crop on this land, if we could raise it, if the season was at all wet. If we had a wet spring we could not plant a crop. Therefore, we raised nothing but bull-frogs.

"Since ditching this land, we can drive over the farm with a car and can harvest our wheat with a header or binder without any inconvenience on account of mud. Neither do the ditches bother as we ditched in such a way as to have no deep narrow ditches.

"The benefit of the ditching did not stop with our own work of reclaiming. When our neighbors saw what a good thing it was they got us to ditch their land in order to carry off the water we drained on to them and to reclaim parts of their farms as well.

"We have 1,200 acres of land in the vicinity of this farm we have drained and reclaimed and consider this land as good as the best. Yet at the time we bought it people criticised our judgment.

"I wish to say that before draining we valued this land at $25.00 per acre and at the present prevailing price of such land in this vicinity, this land, now that it is drained, is worth $125.00 per acre.

"In conclusion I want to say that on the land where we could raise nothing but bull-frogs before, we now raise 40 bushels of wheat to the acre.

"J. W. Smyser."

"I purchased one of your ditching and grading machines last summer, and have given it a good trial. Allow me to say that it is the best machine that ever came to my farm.

"We had 320 acres of flat land on which the water stood whenever it rained. The water would sog the land, and consequently it kept too soft and wet to work.

"I acquired this land about eighteen years ago, and I have always thought a lot of the place, as the soil is of a rich nature and I was determined to get something out of it.

"I got signers and tried to bring the matter of drainage before the Circuit Judge, spending $500.00 of my own money in the effort, but nothing came of it. Then I dropped the whole matter and started after the job myself.

Before draining this land we could not get over $15.00 to $25.00 per acre, but after ditching and getting it into shape I would not take $100.00 per acre for it. The land is rich and will produce more and better crops for years to come than we could get from any other kind of land.

"M. Bodenheimer."

I could read you hundreds of other letters just as interesting but it would consume too much time. The evidence above given is proof conclusive of what this ditcher is doing in the way of solving the farmers' drainage problems.

Soil Washing

In speaking of drainage, I cannot refrain from making mention of soil washing from the hillsides and sloping fields, as these two subjects are so intimately related.

Soil washing as you doubtless know is rapidly becoming one of the biggest problems the American farmer has to face today. Since the timber has been removed from the majority of the uplands and the fields have come under the plow, soil washing has been going on at an alarming rate. In some sections of the country whole fields have been abandoned. Unless some method is devised to end this dreadful waste, many farmers will soon find themselves without any tillable land left.

To many of us as we go about the country, the small washes that are just beginning to appear in the hillsides

mean nothing. We take it as a matter of course. Little do we realize that unless these places are promptly attended to they will soon develop into large gullies, which sooner or later renders whole fields unfit for cultivation. Neither do we stop to consider that it is the soil washed from these uplands that feeds and fills up the beds of streams causing them to overflow on to the low lands doing untold damage.

Here again we are made to see that the problems of drainage and soil washing hinge on the control of water. Water controlled is wealth; water uncontrolled brings disaster.

Field terraces have been found to be the only effective and permanent method to stop soil erosion. It is not my purpose to discuss in detail the big subject of field terracing but I want to say just enough to give you an idea what these terraces are like, in the event you do not already know.

Terraces

Terraces are broad banks of earth, averaging four to twenty feet in width, thrown up on a level paralleling each other running around a hillside or across the slope of a rising piece of land. Their purpose is to check the rush of water down the hillsides, holding it and causing a portion of it to seep into the ground to conserve moisture for growing crops while the balance is allowed to run off gradually around the hill, escaping in suitable outlets provided at the ends of the terraces. Bear in mind a well-graded road and you will at once get an idea of a properly constructed terrace.

For building these terraces the steel ditcher-terracer is without doubt the best and most economical implement on the market today. Being made of the very best steel with ordinary care it will last the farmer a lifetime. Aside from the economic feature, this machine has this advantage over the wooden drag used in some cases for terrace building, in that it can be used for cutting ditches, ditch cleaning, road making and repairing. It eliminates a lot of hard labor and greatly reduces the cost of such work.

Terracing is already extensively practiced in some sections of the country, chiefly in the South and Southwest. The time is coming when it will be as general as plowing, discing, harrowing, etc. It is not an engineering problem. Any farmer can do it.

It is estimated that 75 to 85% of the available plant food is contained in the top six inches of soil. Can we afford to let it go on washing away, The answer is most positively "NO."

Every County Agent, every Extension Worker, all State Agricultural Colleges should not let up in their efforts to teach these two subjects to the farmers. As the population of the country increases, land is not so plentiful as it once was. And since the whole world is looking to America for increased food production, we cannot afford to have any abandoned hillsides and rolling lands or any "loafer" acres on any part of the farm.

It is not the purpose of this paper to talk V-shaped ditcher, but as stated in the outset I desire to show you how in a simple, practical and economical way this implement, through its variety of uses is making it possible for farmers to grow bumper crops on land that was formerly non-productive on account of lack of proper drainage; how soil washing on hillsides and rolling lands can be stopped; how roads can be graded up economically, thus aiding largely in reducing the cost of transporting farm products to market, and putting the whole farm on a better paying basis. Better farms, bigger crops, and good roads bring greater prosperity to the whole community. Prosperous communities make for a better nation. Thus, we are all vitally affected by these two big subjects — drainage and soil washing, or in other words, control of water.

Must Drainage Accompany Irrigation

By O. W. Israelson[1]

To assert that drainage and irrigation are both necessary on a single farm seems paradoxical. Many farmers in the west entertain the misconception that land which occasionally becomes so dry as to need irrigation cannot be benefited by drainage, and conversely that a farm which is so wet as to need drainage cannot be improved by irrigation. The conditions which cause a real need for drainage of irrigated land are frequently perplexing and difficult to control. Some of these conditions will be briefly described.

To apply exactly the amounts of water needed by different plants at the rate the crops absorb and use the water would be ideal irrigation practice, but such application of water is impracticable. In order to save labor and water, and for other less important reasons, it is necessary to apply water at occasional intervals and thus store in the soil a sufficient amount of moisture for the plants during the time between irrigations. To store this

1 Professor of Irrigation and Drainage, Utah Agr. College. Mem. Amer.

amount of water in the soil without, at the same time, applying an amount in excess of the actual need, it is important to know with some degree of accuracy the capacity of the soil for water, its permeability to water, and its degree of uniformity. Even though the irrigation farmer had this information, he would be further limited by the variability in slope of his land, the variable size of stream delivered by the irrigation company, and by the experience and skill of his farm help in the application of water.

The capacity of soils to retain water in a capillary form has been carefully studied by the U. S. Department of Agriculture and by a number of western experiment stations. It has been found that soils of coarse texture having a large proportion of sand retain less than one inch depth of water for each foot depth of soil, and that only the soils of fine texture and favorable structure retain as much as two inches depth of water in each foot of soil. The average soil when dry enough to need irrigation retains about one inch of water in each foot of soil. If, therefore, boring into the soil before irrigation, to determine the depth that needs moistening shows that the upper five feet of soil should be wetted, then the application of enough water to cover the soil to a depth of five inches would be sufficient and the excess, if any, must be taken away by drainage to avoid water-logging of the soil. But most irrigation farmers have little or no information concerning the capacities of soils to retain water; they are in urgent need of engineering assistance to obtain such information. In addition to knowledge concerning capacities of soils for water, information about the permeability of different soils to water is of vital importance.

If it were possible for the irrigation farmer to apply water at one time to the entire surface of his farm, at a rate about equal to the rate at which the soil absorbs the water it would be a simple matter for him to discontinue the application as soon as he had applied the amount the soil could retain. But he must apply the water at one end of his field and attempt to balance the rate of percolation into the soil with the rate of movement over the land surface so that by the time the water has penetrated to the desired depth it will also have moved down the field far enough to cover the entire surface. On farms having uniform and smooth surface slopes and a high degree of uniformity in soil texture, the distribution of water as above outlined without loss of excessive quantities may be accomplished. Many western valleys, however, contain large areas of land having an irregular surface and variable soil texture, and it is impractical to irrigate such lands well without some water finding its way below the soil zone occupied by plants. Frequently, if not usually, the water thus lost percolates slowly to the lower levels of the valleys, where it accumulates in large quantities and rises to the surface under the pressure from above. It thus water-logs the most fertile valley lands. Such conditions make drainage inevitable.

In the state of Utah where irrigation has been practiced less than 75 years it has been found necessary to drain approximately 300,000 acres, or more than 25 per cent of the total irrigation area. This does not imply that the irrigation of any large area necessarily means that 25 per cent of the land will need drainage; far from it. It does show the need for extensive and thorough work by the agricultural engineer in order to reduce to a minimum the loss of water through application of excessive amounts in irrigation and the consequent need for drainage.

In the larger irrigated valleys of the west, such as the San Joaquin Valley in California and the Snake River Valley in Idaho, it is not uncommon to find a gradually rising water table. In many cases the total rise is only a few feet each year. The rise of the water table is, nevertheless, positive, and in periods of ten to twenty years it has frequently risen from an average depth of eighty feet below the land surface to a depth of only a few inches. In many cases the time at which the water table reaches the surface of the ground could have been deferred many years had the irrigators been more fully informed about the capacities of soils for water; their permeability to water, and the amount of water actually used in irrigation. It is not extravagant to say that in some valleys the need for drainage could thus be forever prevented; in others, drainage must accompany irrigation after a few years' use of water.

Notice to Members

The 1919 Volume of "Transactions" of the American Society of Agricultural Engineers was mailed last month. If you have not received your copy please inform the secretary.

The Joint Conference Committee, acting as the Ad Interim Committee authorized by the Organizing Conference of the National Engineering Societies on June 4, 1920, has issued a call for a meeting of American Engineering Council to be held in Washington, D. C., November 18-19, 1920. Dr. E. A. White represented the A. S. A. E. at the Federated American Engineering Societies conference held in Chicago, October 21.

The Clay Products Association, 913 Chamber of Commerce Building, Chicago, Illinois, has prepared a booklet of interest to highway engineers. It is a pocket size booklet about Vitrified Clay Pipe Culverts. It furnishes standard rules and dimensions for obtaining adequate drainage, detailed lists of materials and estimates of costs, rules for areas, tables of strengths and also complete specifications for building culverts.

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The annual meeting of the American Society of Agricultural Engineers in Chicago, December 28, 29 and 30, promises to be the largest and best ever held. Already much interest in the meeting is being shown and a program of exceptional value will soon be announced.

The program committee is giving special attention to interesting subjects of the time and some well known investigators and authorities have been invited to deliver addresses.

Mr. K. J. T. Ekblaw, engineering editor of the National Farm Power, will give an address upon the "Artificial Heating of Animal Shelters." Mr. Ekblaw has been giving this subject special study for some time and is in a position to report some interesting developments.

Mr. J. R. Howard, president of the American Farm Bureau Federation, will give an address upon "The Importance of Machinery as Related to Agriculture." Since machinery will probably play the most important part in solving the problem of greater production, this address should be of special interest to all members and Mr. Howard is in an authoritative position to present the view of the progressive farmers of the day.

Mr. E. V. Collins who is assistant chief in agricultural engineering Iowa Experiment Station, will give a paper upon "Some Factors Influencing the Draft of Plows." Mr. Collins will report the results of investigation continued throughout the summer.

Personals

Prof. O. W. Sjogren, head of the Agricultural Engineering department at the University of Nebraska; Prof. Daniel Scoates, head of the Agricultural Engineering department at the Texas Agricultural and Mechanical Arts College, and Prof. Howard W. Riley of New York State Agricultural College, attended the special conference for agricultural engineers at Washington, D. C., October 22 and 23.

Prof. J. B. Davidson who delivered an address upon "Standardization at the National Implement and Vehicle Convention at Atlantic City, New Jersey, October 20, also attended a special conference on agricultural engineering called by the Division of Agricultural Engineering, U. S. Department of Agriculture at Washington, D. C., October 22 and 23.

Mr. W. W. Smelker of the Roderick Lean Manufacturing Co., is out in California introducing a new orchard harrow which was designed particularly for California conditions but is also adapted to the orchards of the east. The harrow is low down with extended frames and shields enabling the orcharist to cultivate in under and right up to the tree.

Mr. I. W. Dickerson of Charles City, Iowa, was in the office the first of the month. Mr. Dickerson is a member of the Executive Council and some of the plans for next years were discussed.

Mr. J. Bertino de M. Carvalho of the Landon C. Moore Laboratory at Dallas, Texas, is leaving the United States for South America soon where he will continue his special study of fats and oils. His new address will be 76 Rua do Corpo Santo, Bahia, Brazil, South America.

Mr. Walter T. Ackerman is now connected with the Agricultural Engineering Department at Iowa State College. Mr. Ackerman goes to Ames from the Connecticut State Agricultural College.

Mr. Richard D. Chapman, formerly general sales manager of the Taylor Wharton Iron & Steel Company, and subsidiaries, is now president of the Pharo Manufacturing Company, 1336 Woodward Avenue, Detroit, Michigan. The latter company manufactures the Pharo oil operated governor, a positively driven device for regulating the speed of truck and tractor engines and other internal combustion engines.

Mr. Goichi Tsuda, engineer of the Department of Commerce, Industry and Agriculture of the Japanese Government has been sent to this country by the Japanese Engineering Standards Committee, which has recently been organized, to investigate engineering standardization.

Mr. Jas. Arentson, Memphis, Tenn., has accepted a position with the Department of Education at Nashville, Tennessee, beginning December 1.

Dr. E. A. White, technical editor of *Farm Implement News*, was appointed by President F. N. C. Kranich to represent the American Association of Agricultural Engineers at the meeting of the Engineering Council held at Chicago, October 21. This meeting was called to finish up the work of the Engineering Council and then turn it over to the Federated Engineering Societies. This action was deferred, however, and the Engineering Council will meet again at its regular time.

Dr. White reported that the organization of the Federated Engineering Societies had gone far enough to insure its success. It was then supported by over twenty engineering societies. Dr. White recommended that the A. S. A. E. accept the offer to become a charter member.

Subduing Arid Lands in the West

By Alfred R. Williams [1]

"WHAT a splendid opportunity to make a fortune if this land could only be watered!" The remark was made by a young college man as he stepped from the train at a little railway station in Wyoming, where the train had stopped for a brief twenty minutes in order that its load of homeseekers might avail themselves of the opportunity to indulge in pie and coffee. On both sides of the railroad there stretched a rolling topography consisting mostly of stretches of heavy gumbo soil, interspersed with patches of grease wood.

It was well that the speaker did not see the humorous smile on the face of a listening cattleman, loitering on the station platform. For the cattleman knew, as do most men who know western conditions, that there is such an anomaly as irrigated farming land, and "land that has water on it," and that between the two there often is as much difference as between the rocky hillside farm of New England and the fertile prairies of Iowa or Illinois.

The remark of the young college man typifies the frame of mind that many homeseekers have, when, after absorbing the attractively written literature sent them by the irrigated land companies, they join one of the monthly or bi-monthly railway excursions and go out to look over, and often to choose a farm. It has not occurred to them that there may be many other factors fully as important as a plentiful supply of irrigation water, which may mean all the difference between success and failure in the farming venture. It fell to the lot of the writer to be connected with one of the largest companies dealing in Wyoming irrigated land. As an irrigator and farmer's advisor it was his privilege to come in close contact with a score or more farmers on one particular project, from the time they arrived on the land till the close of the season. All the conditions, as well as the experiences of farmers, given in this article were observed by the writer, and it is believed that they are fairly representative of other Cary Act, or private irrigation projects, similarly situated. With the possible exception of the high altitude, the average homeseekers on the privately controlled projects will be liable to encounter much the same conditions.

On this particular project, there are some 10,000 acres covered by the irrigation canal, though it must not be inferred that all this land is in cultivated farms. The nearest railroad is seventy-five miles away; communication with other parts of the state being by telephone, and daily mail and stage service.

Natural vegetation consists of a scant growth of native grass, and sage brush. Some grease wood is to be found along the streams. The soil varies from a light sandy loam on the upland, to a medium clay on some of the hill slopes, and a heavy, sticky, gumbo soil on most of the level areas to be found in the tract.

With this descriptive preface, we now come to conditions on the project as found by the new settlers, and by the writer when he arrived. It was on the first of June after a long dusty journey of seventy miles behind three relays of stage horses, that the stage pulled up at the town postoffice just at dusk. The majority of the settlers then on the project had come a month or so sooner, about the first of May. If they had arrived sooner they could not have commenced working the land or even started fencing, the two first tasks of the settler, because the snow often does not melt on these uplands perched 6,800 feet above the sea, until the middle of April. In the meantime the roads are almost impassable for the heavily loaded wagons. After arriving on their "farms," the boundaries of which some did not even know, the settler had to put up some sort of shelter, usually a tent, unload the household goods brought along, and go a mile or two after water for both man and beast. It is too early to irrigate, and consequently there is no water turned into the canals; and, of course, no time has been had to dig a well, where good water is to be found at a reasonable depth. Then, there is the problem of getting feed for the work horses until the grass comes; this is no small task, for generally the ranchmen living along the streams have no hay to sell, and what hay is sold brings an exorbitant price in the spring of the year.

After a week or so of "getting started," the settler was ready to start work upon the land. This should mean plowing and does, of course, with all farmers who know conditions under which irrigated crops must grow. However, due to a lack of good horsepower, and possibly to a lack of definite information as to the depth the sod should be broken, there resulted on the whole a great diversion of opinion as to how the sod should be tackled. One man started in to break up the sod six inches deep, and ended up by breaking two inches. His team could not stand up under the work. Another wanted to break up as large an area as possible and proceeded to hardly skim the surface. As a result he half ploughed some thirty acres, leaving much unploughed land, and more uncut sage brush, the latter proving a serious obstacle to further tillage operation. Two other farmers had stretches of very level gumbo land with no sage brush, and decided, that as the season was growing late, not to plough at all, but to disc the soil three or four times and seed their grain and timothy seed. There were no late spring rains, the seed did not germinate, and so the land had to be irrigated in order

[1] Field Superintendent, Great Western Sugar Co., Longmont, Colo. Assoc. Amer. Soc. A. E.

for the crop to come up. Then, before a sufficient growth could be made to shade the soil and check evaporation, the heavy gumbo had baked and cracked and in order to keep the crops growing at all, it had to be irrigated within ten days of the first irrigation. Need it be said that the yields did not measure up to those stated in the literature sent out by the company, and which yields, though unwarranted, many of the settlers expected to realize the first year?

Another handicap under which the settlers suffered was that of planting varieties of crops totally unsuited to the altitude and consequent short season. This could have been prevented had the company's manager been enough of a farmer to know what varieties of crops were adapted to the section, and ordered seed stock accordingly.

It was the writer's experience in working and talking with the farmers that with hardly an exception they all expected to "get rich" in four or five years, and this without even the labor expended on the crops in humid regions. It seemed to be their opinion, that the water did most of the work or rather took the place of thorough tillage. "Let the water run and work while we sleep," seems to be the prevalent idea. This idea came in part from the impression conveyed by the company's agents and literature and partly from the ignorance of the settlers concerning irrigation farming.

Much emphasis is usually made by irrigated land promoters upon the fact that not much capital is needed to start farming under irrigation. It was the writer's conclusion after studying the farmer's needs on this particular project that the more ready capital the homeseeker has, the better chance he will have of making a success of his venture. This means, that besides a good team wagon, farming implements and fencing material, a settler should have from $1,000 to $1,500 in a position to be drawn upon in the case of need and to fall back upon in case he does not harvest a good crop the first year.

It would not be proper to point out the mistakes made by both the settlers and the company without also suggesting ways by which these mistakes might be lessened, and in some cases eliminated.

First, the settler: He should not select too much the first year or two, no matter how fertile the soil, or glowing the promises made to him by the company. He should be sure that he understands the limitations of the region in which he has chosen to farm, the crops that will not grow as well as those that will grow. He must come prepared to do a lot of hard work in getting his land into shape before it will produce good crops. This will include thorough breaking, gathering and burning sage brush in many cases, and leveling off knolls and ridges in his fields, so that spreading the water over the land may be made easier.

The settler, and his family if he has one, must realize that they will have to forego many inconveniences when they move to a new location such as we have been discussing, and in many cases must undergo real hardships till a house is built and the land brought under cultivation. The sod should be broken as deeply as time and horsepower will permit, up to a depth of five or six inches, unless the soil is a heavy clay, when a shallower ploughing will be in order. It must be remembered that the arid soil has lain practically dormant, as far as producing is concerned, for ages, and the mere application of water does not produce a magic effect immediately. The average farmer, new to the irrigation business (and often the experienced as well) gives the crops too much water. There is a mistaken notion that because a little water will produce an increase in crop yield, the more applied the greater the yield.

The most important point it seems to the writer, that irrigation companies should consider, is that of establishing their projects on a sound economic basis. This means among other things, that attention must be given to the question of markets, for of what gain is it to the settler if a certain crop does well if he has no means of disposing of it at a profit? It is well known that the reason 75 per cent of the irrigated land companies in the west fail, is because they have been planned without considering the economic factors involving the project as a whole. The canal system and water supply may be fully adequate but if the altitude, markets, season and soil be not in the right relation to each other, the project has not a sound economic principle on which to grow. To quote from an address given before the Oregon Irrigation Congress, by L. M. Rice, Civil Engineer, "The engineers should go beyond the mere building of structures through which the water is transmitted. He must look to the foundation upon which the whole structure is builded."

Everything that conduces to the contentment of the settlers during the first trying years should be a matter of concern to the irrigation companies. It is good policy for them in selling additional land, and keeping the settlers already on the project from getting discouraged with the proposition, from throwing up their claims and going back to "God's country," as many of them express it. To this end, all the lateral systems on the farmer's land should be constructed by the company, as the farmer gets ready to use them. Under the policy of lessening the expense of the water right, and only conveying water to the boundaries of each claim, the settler is left to build his own field laterals. Knowing little about lateral systems, and less about the force of moving water, the newly arrived farmer, unless he has the aid of an engineer, is fully as liable to run his laterals directly down the steepest slopes, as along the contours, and when the water has cut a deep channel, wonders why he cannot control it and gets further disgusted with irrigation work in general.

To quote again from the able address of Mr. Rice: "The engineer should see that every detail of construc-

tion has been carried out, that there is nothing left in the shape of construction work for the man on the land to do. The clearing of the lands on an irrigation project, removing the stones and leveling of the same, in order that water may be placed upon it, is just as much construction work as the building of the head works, and no project is complete until such time as the man upon the land is able to produce crops, and through the sale of same, is able to live and pay the necessary charge levied against him."

Government Reclamation Service has done much in putting irrigation "on the map" in the west, due largely to the thoroughness of the work which has been done, and the close attention to details on each individual project. Yet with all that remains for the government to do, there are many tracts of splendid soil, small in area as compared with the government projects, which, because of their small area will only be developed by private capital under the Cary or other land acts. And it is for this reason that the west should not be made to suffer as a result of mismanaged private schemes, and a serious setback given to irrigation development. For, with the exception of a few scattered localities, it will always be true of land west of the one hundredth meridian, that —

Little drops of water,
Mingled with the sand,
Make a mighty difference
In the price of land.

Tile Drainage Projects a Good Demonstration for Agricultural Extension Work

By R. L. Patty

THE object of Agricultural Extension is to secure better practice in the farming business. Talking and writing is all right but the way to get a man to follow a good practice is to show him that it is good and he will follow alright. Hence, the value of a demonstration. Engineering projects are especially favorable for demonstrations since they can be seen and are permanent. Tile drainage projects will show results with the best of them. Agricultural land properly tiled is the best in the world in either a wet or dry season, while farming undrained or improperly tiled land today is not only uncertain but an extremely expensive proposition. It is a question whether poorly tiled land is any better than land that has never been drained because often big losses in seed and work are experienced through trying to farm it when otherwise it would be left to the frogs and ducks.

Many millions of dollars have been wasted by mistakes in laying drain tile, through the cost of installation and through the attempt to crop the land. The writer has realized this more keenly perhaps from having grown up in a section where this waste has been appalling, and also from having worked at drainage engineering work through southern Minnesota where much work is being done over even a second time.

Now, if we have established our claim that the cause is a worthy one, let us consider the mistakes that are made in tiling and points of good practice that may be shown in a demonstration. Mistakes in installing these systems have been made in using main tile that were too small, in not having the tile laid to an engineer's grade, in not laying the tile at proper depth, in not using lateral tile on the flat ground, in not laying out the laterals to advantage and in improper protection for the outlet. These are a few of the points that may be shown to mighty good advantage in a demonstration project. They are all important. Mistakes in all of the above points may be found on many of the old projects, and a great many violations of the best practices may be found in recent installations.

We believe the readers of this magazine being mostly engineers, will be interested in the way the demonstrations have been carried out in South Dakota and in the results obtained from them. We were lucky in getting into the State before very much tile drainage work had been done. They had wasted the customary amount of money on the small open ditches put in with the capstan plow but had not wasted much on poor tiling. However, the water level tilers were drifting this way, being driven out of Minnesota, ahead of the drainage engineers and tilers who lay the tile to grade and we were none too soon. While the highway work has since called many capable engineers into the state and many with experience in drainage, four or five years ago engineers who did any amount of drainage work in South Dakota could be counted on the fingers of your two hands, with some to spare. The result was that in many sections of the state we had neither engineers to lay out the system and stake the grade nor tilers to lay the tile to that grade. But after looking over the field we reached the conclusion that

[1] Extension Specialist in Agricultural Engineering, South Dakota Agricultural College. Assoc. Amer. Soc. A. E.

there was no phase of Agricultural Engineering work in extension so important to the state in dollars and cents at that critical time as tile drainage demonstration work. Consequently, we "waded into it." The first step was to get in touch with the project that would make a fit demonstration. This has been accomplished largely through

A small but interested group of farmers watching a good tiler lay tile to an engineer's grade at a demonstration field meeting

the County Agents. In being called out to a project as an advisor we could look it over, make recommendations, and if it was found feasible for a demonstration of farm drainage we could arrange to lay out the system, figure the size of the tile, make recommendations as to the outlet protection, figure the grade, and in many cases it has been necessary to put the owner in touch with a tiler who lays tile to an engineer's grade. In many cases, especially if there was any doubt that the system would be put in, the tile needed was estimated and no staking done until they were on the ground. The uncertainty of getting tile has also made this procedure necessary in many instances. After the tile were laid another visit was made to check them up. In most cases a percentage of the money had been held up until they were checked. This practice has verified our view that checking up drain tile on farm systems by the engineer is a worth while practice, as many mistakes have been found which would have been seriously damaging to the systems.

Meetings have been held on these demonstrations at various times during the process of installation and afterward. Occasionally, at the very first stages when the system is being staked out, a little talk may be given on good practices in drainage at any one of these times but we have found the most effective time to be just as the laterals are being finished. The visiting farmers are interested in seeing the tile, how deep they are laid, how large they are, and how the laterals are laid out. If we can arrange to hold this meeting just before the tiler finishes work, we get him to lay some tile to grade while they watch him and this is of considerable interest. It also serves to emphasize the fact that the tile are laid to grade. Another good time to hold a meeting on a tile drainage project is when the crop is at the stage to show up well. This may be the first, second, or third year after the work is finished. In fact, when it is most convenient to arrange it. This makes it possible to handle a larger number of demonstrations. As stated above, engineers with drainage experience are coming into the state now and we are beginning to be able to use some of their projects for demonstrations. In fact, we expect to use them just as much as possible and hope soon to be able to depend on them entirely for our demonstrations.

Limited to Farm Systems Only

We limit the projects which we lay out to farm systems alone. Outlet systems involving several farms in a basin and usually resulting in a public system are merely given the "once over." Such recommendations made as will make it easier for the engineer secured to handle the project, to put through a satisfactory system. Public or county outlet systems are subject to the approval of the State Engineer's office in this state, so our work may be said to begin where the county ditch leaves off in many instances. There are, of course, many farms in the state having legal outlets into streams where a coöperative outlet system is not necessary.

Object We Are Working For

Our major idea in this work has already been brought out. We are trying to impress both the land owner and the engineer with the importance of the proper installation of the farm system, for it is true that we find engineers that underestimate the importance of this. Some of them carry the idea that the farm system is hardly worthy of their attention; that if the outlet system is properly put in the laying out and installation of the farm system may be left to the tilers. We have not found this a safe practice. Many outlet systems, usually public projects, have made a poor showing owing to the fact that the farm systems have not been put in correctly or have not been put in at all. We believe the engineer should make a greater effort to have the farm systems put in when the outlet system is installed and to give them the most careful consideration.

Results We Have Obtained

That we are getting results from this work is evidenced from the fact that whereas when we started the work practically no tilers could be found who laid tile to an engineer's grade, there are now dozens of crews working over the state and we doubt if a single tile could be laid "by guess" for the land owners in many of our counties.

While the general encouraging of tile drainage has been a secondary consideration on our part, we find that the demonstrations are doing the talking for us and the supply of drain tile has not been sufficient to supply the demand during the past two seasons.

Drainage and the Agricultural Engineer

By Bert R. Mullen*

WHEN is the cost of living going to return to normal? This question we are hearing from North to South. We cannot expect it to decrease very rapidly, but can not we all do our small part by helping to bring it back? The country needs greater production and more efficiency.

The most of us could be more efficient if we would — or, without injuring ourselves very much, we could work an extra hour now and then until the desired end was reached. If some of us could see the efforts that the people of Germany are putting forth in order to regain their feet, it would put a little shame into us and set us to thinking and wondering what we could do.

Picture of corn on Mr. A. F. Whitfield's farm, Middlesboro, Ky. This was formerly a swamp but last year, after drainage produced seventy-three bushels of corn per acre

We, as Agricultural Engineers, can do much to increase production and help the situation in general. It is true that we are not all farmers, but still we can do our part in whatever work we are following.

For instance, there is the Drainage Engineer. If an Agricultural Engineer is not qualified for this work, who is? This is one field which is open and in which we could do our share to increase production and at the same time to make a good honest living. We can either promote the work and then turn it over to some one else for completion, or we can equip ourselves to carry it through. It takes competent men to do this work and farmers are continually inquiring where such men can be obtained.

The writer knows of one instance in the South where a Tile Manufacturing Co. keeps a Drainage Engineer employed by the year for the express purpose of working with the plantation owners to see that the drainage is properly installed.

Another Tile Manufacturer had difficulty in disposing of his product — not because the farmer did not want it but because help could not be obtained to do the tiling. He purchased a ditching machine, employed a competent man to run it and soon had so much work contracted for that it was necessary to buy a second and then a third machine.

Ditching machines cannot be used to advantage under all circumstances, but in most parts of the country can be used to a great advantage. They not only help to solve the labor problem but they net the operator a good neat sum on his investment.

At present, ditching contractors are receiving from 2½ to 3 cents an inch for each inch in depth of ditch per rod. Taking a minimum of 2½ feet in depth and 2½ cents per inch, it would amount to 75 cents per rod, or $75.00 per day, as 100 rods is considered a conservative day's work.

We will not argue the point that tile drainage is a profitable investment for the farmer. It is true that the cost of drainage has increased during the past three or four years, but on the other hand have not land values increased much more in proportion? Large land owners who have drained several hundred acres are going ahead with the work,

* Salesman and engineer, Dickey Clay Mfg. Co., Mem. Amer. Soc. A. E.

as they are in a position to realize its worth even at the increased cost. Numerous instances could be sighted both in the state of Missouri and other parts of the middle West and South where vast areas are, at this time, being reclaimed, by drainage.

How many farms are there where at least a few hundred feet or rods couldn't profitably be tile drained? Converting ten acres from a non producing or a ten bushel per acre into a sixty bushel yield would pay the taxes on a good sized farm. As Mr. A. F. Whitfield of Middlesboro, Kentucky, told the writer, "The value of that nine acre field before draining was nothing; after draining it is worth as much as any other land which raises an average of sixty bushels of corn per acre."

As an example let us take the ten counties in North Central Iowa which comprise the larger part of the Drainage Area of that state. (The total increased acreage to corn from 1905 to 1914 was 183,620, with a total increase of 20,224,148 bushels). Webster county took the lead with an increased acreage of 35,307 and an increased yield of 2,225,815 bushels. The average increase for the other eighty-nine counties during the same period was 1,464,216 bushels.

The above is merely an example of what is being done and what can be done. The U. S. Department of Agriculture estimates that there are 150 million acres of lands now classified as cultivated that could be drained with profit. This does not include some seventy-five to eighty million acres of swamp and overflowed lands.

This is a vast and useful work and why not let the Agricultural Engineer take the lead in the years which are to come?

Important Agricultural Engineering Conference

A significant conference was held in Washington, D.C., last month, to consider the more rapid development of agricultural engineering research and education through more effective coöperation between state and federal agencies. Invitation was extended by Mr. T. H. McDonald, chief of the Bureau of Public Roads, and Mr. S. H. McCrory, in charge of the Division of Agricultural Engineering in the Bureau, to a few of the men in charge of the agricultural work in the state colleges and experiment stations to attend the confernce. Report of the conference follows:

That the nation cannot exist without agriculture is perfectly obvious. The tremendous production of the American farmer during the World War would seem to be an indication of a thoroughly satisfactory condition of the industry in the United States. At a matter of fact, however, this emergency output of food was secured only by an unusual exertion on the part of the farmer which cannot be expected to continue, so that the food production per worker is certain to decrease. The food requirements of the country are, however, constantly increasing and should, therefore, for safety, be accompanied by either an adequate increase of the farming population, or the introduction of methods which will continue to increase the producing power of the individual. The rural population is not increasing in as great a ratio as the total population. This condition of affairs should occasion serious concern and every possible effort should be made to provide a remedy by making farming sufficiently attractive to hold the desired number of workers in the field.

For the accomplishment of this result there must be brought about:

(a) The improvement of living conditions on the farm by the general betterment of dwellings and the introduction of modern time- and labor-saving devices;

(b) The increasing of the efficiency of the individual farmer to the end that his productive capacity be increased, his earning capacity be raised and funds be provided for maintaining the desired standard of home life; and,

(c) The enlargement of the productive area of the country by the clearing of stump lands, the drainage of wet areas and the irrigation of arid regions.

The accomplishment of these purposes constitutes the field of agricultural engineering which may be defined as the application to the needs of agriculture of many phases of civil, mechanical and electrical engineering, and of architecture. In the development of this field much progress has been made. The first steps having been taken by the individual farmer in planning and building his home and then by devising crude machines to aid in his field work. The next work was done by manufacturers in the refinement and wholesale production of field machinery of designs based in most cases on the original ideas of farmers, a work of very great importance, but a development much of which was accomplished under stress of commercial necessity to meet immediate needs and which was often, therefore, not conducted in a systematic or orderly manner and the information secured has not been made available. Recently there have developed several commercial and engineering societies more or less closely allied to agriculture whose proceedings afford much useful information. Finally, there exist the Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture and departments of agricultural engineering in various State Colleges and Experiment Stations created in recognition of the existence of the science and art of agricultural engineering and for the purpose of gathering, organizing and disseminating the facts already available in this field and for the purpose of conducting experiments for ascertaining new facts and extending to new fields better engineering methods.

It is clear that only through the complete coöperation of the various agencies engaged in the work can there be secured substantial progress in solving the agricultural engineering problems of the present and future, or can there be attained efficiency in the dissemination of the useful agricultural engineering information now available or to be obtained from future research and surveys.

For discussing the development of agricultural engineering in all its various phases, there was held in Washington, on October 22nd and 23rd, 1920, a conference

which, after due consideration of the conditions and relationships involved and the status of the work in general, finds as follows:

(a) It is to be recognized that the greater part of the burden of investigation and education in agricultural engineering necessarily must be cared for by state agencies, because of their greater resources in funds and men. Many problems are of a local or regional importance and naturally should be studied by local organizations. Furthermore, much may be gained by a division of effort and the assigning of specific parts of large and general problems to certain institutions.

(b) It seems fitting that the U. S. Department of Agriculture should take the lead in coördinating and stimulating the work of the State Colleges and Experiment Stations, or other agencies on local or specific problems. In this work there should be full coöperation and a special effort should be made to maintain the individuality of the state organizations and of the individual workers. It may well be expected that the U. S. Department of Agriculture should supplement by its own surveys and investigations, the work which for any reason can not adequately be performed by the State Colleges or Experiment Stations.

(c) As a basis for preparing a program of coöperative work, it is well that existing information and data be organized and prepared in such a form as to not only be readily available for dissemination, but also to serve as a guide in outlining research and survey projects. This work being of a general character, may well be committed to the U. S. Department of Agriculture.

(d) In order to carry out the foregoing suggestions and to secure full coöperation, it is desirable that there be held conferences composed of representatives of the U. S. Department of Agriculture, the State Colleges and Experiment Stations, and a representative of the American Society of Agricultural Engineers. Such conferences should consider and make recommendations regarding the problems to be taken up and the assignment of entire problems or parts of problems to such agencies as may be, in their opinion, best fitted to prosecute the work.

Signed, H. W. RILEY,
Department of Rural Engineering,
Cornell University.
D. SCOATES,
Agricultural Engineering Department,
Agricultural and Mechanical College
of Texas.
J. B. DAVIDSON,
Agricultural Engineering Department,
Iowa State College.
OSCAR W. SJOGREN,
Agricultural Engineering Department,
University of Nebraska.
S. H. MCCRORY, Engineer in Charge,
Agricultural Engineering,
Bureau of Public Roads,
U. S. Department of Agriculture.

Brush Clearing Valley City Levee and Drainage District, Pike County, Illinois

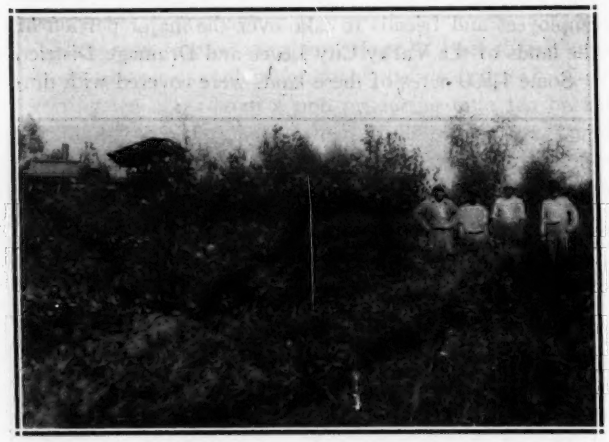
Recently the Edmund T. Perkins Engineering Company, Chicago, Illinois, organized a syndicate of its office employees and friends to take over the major portion of the lands of the Valley City Levee and Drainage District.

Some 1,500 acres of these lands were covered with timber or a thick growth of brush. The timber will be cleared during the winter months, but a considerable amount of clearing has already been done on the brushed areas. It was their expectation that the clearing of this brush would cost from $20.00 to $23.00 an acre, by ordinary methods of clearing with ax, brush hooks or by pulling.

No. 1. Brush cutter in action

No. 2. Man clearing brush after machine has passed

Mr. H. G. Edwards, member of the American Society of Agricultural Engineers, was employed as Farm Manager. He devised a brush cutter modeled somewhat along



No. 3. Holt 10 ton tractor and brush cutter with clearing gang in foreground, brush land in background

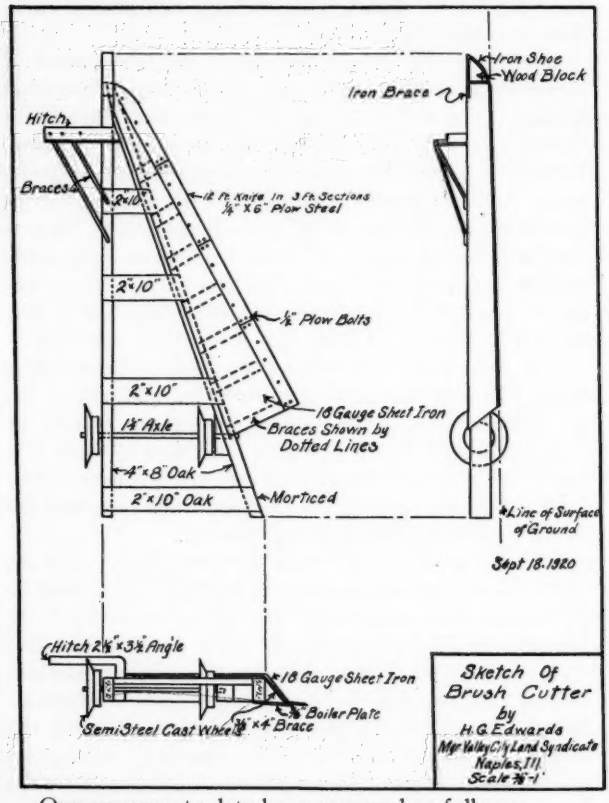
the lines of a brush cutter which he had used in Canada, but with several marked improvements, as shown by sketch. To this brush cutter was hitched a ten-ton Holt tractor and the power of this tractor is the underlying factor of success in the clearing, the brush cutter being so designed as to throw the knife blade against the brush and trees and it has cut without any difficulty Cottonwoods and Willows up to a diameter of eight and ten inches.

Mr. Edwards is improving this cutter and plans to place

No. 4. Cleared land

it on the market after his patents are received. The mode of operation is as follows:

The cutter with tractor attached moves around the outside of the brush area constantly cutting its way to the center. At intervals behind the tractor are placed a number of men whose duty is to pick up the brush as cut and move it out of the way of the tractor upon the succeeding round. Picture No. 1 shows the tractor in operation felling a group of small trees. The second photograph shows one of the men removing the brush as cut. The third photograph shows only a narrow strip of brush remaining, the tractor on one side of the strip and the men upon the other. The fourth picture shows the land as cleared. Of course this does not remove the stumps or roots of the brush. This will be done by pulling or plowing.



Our expenses to date have averaged as follows:

5 men moving brush 34 hours at 40c per hour	$ 68.00
1 engineer 34 hours at 50c per hour	17.00
Gasoline, 90 gallons at 27.2c	24.48
Oil and grease	4.50
Depreciation and interest on machinery	8.40
Total cost of clearing 20 acres	$122.48
Total cost of clearing 1 acre	6.14

This estimate covers the actual time put in by the men while machine was cutting and being overhauled.

When changes are completed on the brush cutter, we expect to cut this brush at a cost of $3.75 an acre.

The Secretary would appreciate it if members would suggest possible authors of papers either for the Journal or the annual meeting.

New Members

Howard Bertrand Bliss, specialist in rural engineering, Knoxville, Tenn.

Wm. Webber, designer of harvesting machines, McCormick Works of International Harvestor Co., La Grange, Illinois.

Clinton A. Hagadone, designer, International Harvester Co., Western Springs, Illinois.

Arthur Francis Graham, Jr., experimental engineer on spry wheel, H. C. Dodge, Inc., Newtonville, Mass.

Wyatt Arnton Clegg, associate porfessor of agricultural engineering, Georgia State College, Athens, Georgia.

Edward Hall Kimbark, assisting supervising design, International Harvester Co., Chicago, Illinois.

B. R. Benjamin, superintendent of experiments, International Harvester Co., Oak Park, Illinois.

Harvey B. Heider, mechanical engineer, Luce Sugar Cane Harvester Co., Watertown, Wisconsin.

Samuel K. Dennis, superintendent of experiments, International Harvester Co., Chicago, Illinois.

Will Huddle, designer, International Harvester Co., Chicago, Illinois.

J. R. Bateman, sales engineer, Hyatt Roller Bearing Co., Chicago, Illinois.

Robert Leon McKnight, agricultural representative, Hercules Powder Co., Memphis, Tennessee.

Ralph L. Ford, assistant superintendent experiments, West Pullman Works of Interantional Harvester Co., Chicago, Illinois.

James A. Moxey, superintendent of experiments, International Harvester Co., Chicago, Illinois.

Edward Mowry, superintendent of experimental department, International Harvester Co., Rock Falls, Illinois.

Alex. C. Lindgren, manager plow experiments, International Harvester Co., Evanston, Illinois.

Howard David MacDonald, assistant manager gas power engineering, International Harvester Co., Riverside, Illinois.

Oliver Brunner Zimmerman, engineer, International Harvester Co., LeGrange, Illinois.

Francis Kildare Flynn, chief engineer, Luce Sugar Cane Harvester Co., Watertown, Wisconsin.

Priestly Howard Williams, salesman, Hercules Powder Co., Memphis, Tennessee.

Wm. S. Graham, superintendent of experiments, International Harvester Co., Canton, Illinois.

C. R. Raney, designer of agricultural machinery, International Harvester Co., Chicago, Illinois.

H. A. Watson, manager, Domestic Engineering Department, Crane Co., Memphis, Tennessee.

Arthur Johnson, Experimental Department, International Harvester Co., Chicago, Illinois.

Charles Pearson, designer of agricultural machinery, International Harvester Co., Chicago, Illinois.

Edward S. Charles, designer, International Harvester Co., Chicago, Illinois.

Amoldus S. Brumby, assistant professor agricultural engineering, A. & M. College of Mississippi.

Douglas Luther Arnold, chief engineer special engineering, International Harvester Co., Oak Park, Illinois.

Wm. L. Beall, superintendent of experiments, Chattanooga Plow Co., Chattanooga, Tennessee.

L. J. Bohn, secretary and treasurer of Motor Institute, Inc., Minneapolis, Minnesota.

Guy Browning Arthur, general sales and advertising manager, Waterloo Construction Machinery Co., Waterloo, Iowa.

Sylvanus Dyer Locke, vice president and treasurer, Locke Steel Chain Co., Bridgeport, Connecticut.

Ward R. McGanen, McGanen Tractor Co., Missouri Valley, Iowa.

Applications for Membership

All members are asked to promptly send all pertinent information, concerning the applicants, to the Secretary's office in order that it may be brought to the attention of the Council prior to the applicant's election.

C. H. White, superintendent Deere & Mansuer Works, Moline, Illinois.

Edwin Courtney Billings, Service Department, J. I. Case Threshing Machine Co., Racine, Wisconsin.

Samuel Eugene Craig, Chief Draftsman Gas Tractor Department, J. I. Case Threshing Machine Co., Racine, Wisconsin.

Geo. H. Dechant, Advertising Manager, J. I. Case Threshing Machine Co., Racine, Wisconsin.

George G. Dana, Chief Draftsman Main Works, J. I. Case Threshing Machine Co., Racine, Wisconsin.

Ellis S. Echlin, Service Engineer, J. I. Case Threshing Machine Co., Racine, Wisconsin.

Ira L. Johnson, Experimental Engineer, Minneapolis, Steel and Machinery Co., Minneapolis, Minnesota.

Norman R. Krause, Mechanical Engineer on Experimental Designs, J. I. Case Threshing Machine, Co., Racine, Wisconsin.

J. H. LaPrince, Senior Sanitary Engineer, U. S. Public Health Service, Memphis, Tennessee.

Howard Ross Tolley, Agricultural Engineer, U. S. Department of Agriculture, Washington, D. C.

K. J. T. Ekblaw, Chief Farm Engineering Department National Farm Power, Chicago, Illinois.

J. I. Winchell, Manager Tractor Department, Horst & Strieter Co., Rock Island, Illinois.

Arch R. Crawford, Advertising Manager "The Farmer," St. Paul, Minnesota.

J. F. Forrest, Proprietor Electric Farm, Poynette, Wis.

Robert Ethan Allen, Agricultural Engineering, West Virginia University, Morgantown, West Virginia.

James Edward Holbrook, Factory Sales, Yuba Manufacturing Co., Marysville, California.

John D. Parsons, Professor Agricultural Engineering, University of Nebraska, Lincoln, Nebraska.

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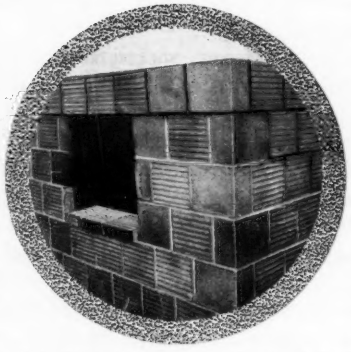

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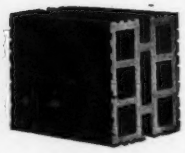

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